How Have Popular News Media Representations of Chinese International Students Changed Since the COVID-19 Outbreak: A Structural Topic Modeling and Sentiment Analysis Aproach

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Abstract

China has been the top source for international students in the US. Chinese international students are also popularly discussed in US news media. However, the worldwide COVID-19 outbreak has drastically impacted Chinese international students in the US, and so is the news portrayals of Chinese international students. Thus, this study investigated how COVID-19 has impacted popular US news representations of Chinese international students. Specifically, this study used structural topic modeling and sentiment analysis to dscover topic/theme and sentiment changes in portraying Chinese international students pre and post-COVID. The results showed significant topic changes, as news focused more on academics and educations before the pandemic, and on addressing challenges and stress after the pandemic. However, the sentiment changes were not obvious. This study explores the news representation differences on Chinese international students before and after the COVID-19 outbreak, providing insights for Universities/Colleges to improve policies and resources for Chinese international students.

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Introduction

Over the past decade, studying abroad has become popular, especially for Chinese students studying abroad. According to the National Bureau of Statistics of China, overseas Chinese students peaked at 703,500 in 2019, of which over 300,000 were studying in the US. For the US, China serves as the largest source of international students in the US, accounting for about 35% of foreign-born students in the US (opendoors.org, 2022). Therefore, Chinese international students are playing a significant role in the cultural diversity and internationalization of the US society (Abelmann & Kang, 2014; Chen & Zhou, 2019; Zhang-Wu, 2018). As a result, Chinese international students are widely discussed in US news media, including topics such as students' experiences, challenges & stress, and also typical views or stereotypes towards Chinese international students (Abelmann & Kang, 2014; Jacobs & Mitchell, 2021; Suspitsyna & Shalka, 2019; Xu, 2022). News articles, as official, reliable, and generally available resources, often provide essential information the public, especially decision-makers for policies related to international students in higher education institutions. For instance, positive news articles about Chinese cultural centers/organizations in universities might inspire other institutions to adapt similar structures to help Chinese International Students push through the cultural shock phase in their journey of education.

Thus, these discussions about Chinese international students in news media attracted researchers to study new media portrayals or representations of Chinese international students (Abelmann & Kang, 2014; Jacobs & Mitchell, 2021; Suspitsyna & Shalka, 2019; Xu, 2022). Various topics about Chinese international students are discussed in popular news media. For example, Abelmann and Kang (2014) discussed the two competing views

in the New York Times of Chinese students studying in US universities. On the one hand, diligent Chinese students seeking more liberal education find American universities resourceful and enlightening. On the other hand, some Chinese students who cannot get into universities in China decide to enter mediocre US universities. Su and Borah (2021) compared news representations of overseas Chinese students in China Mainland, Hong Kong, and the US. The results show that US and Hong Kong news media tend to view overseas Chinese students as liberalists and education seekers, while Chinese Mainland media tends to view overseas Chinese students as victims and patriots.

In recent years, the COVID-19 outbreak has drawn more attention to China and Chinese international students. However, the coverage of China and Chinese international students in US popular media have shifted during the pandemic. Topics related to racism, discrimination, and "Asian hate" increased in social media postings and news articles against China and Chinese international students (Gao, 2022; Nguyen et al., 2020; Zhang & Trifiro, 2022). Furthermore, the number of Chinese students studying in America decreased by about 15% in 2020 as compared to 2019 and continued to decrease in 2021, according to the 2022 Open doors report (opendoors.org, 2022). Possible reasons for this decrease involve the hardship of online classes, time zone differences, uncertainties of COVID-19 quarantine policies, and so on. The impact of COVID-19 was intensive on higher education, especially for Chinese international students (Mok, Xiong, Ke, & Cheung, 2021; Xu, 2022; Yu, 2021).

Therefore, it's worthwhile investigating the differences in news media coverage of Chinese international students before and after the COVID outbreak. This study will explore the following research question: Does the COVID-19 outbreak have a negative effect on the popular news media representations of Chinese international students? In particular, I will seek to answer two sub-questions: 1) What topics are correlated with each time periods according to Structural Topic Modeling? 2) Are topics (words associated with the topics) more positive before the COVID-19 outbreak than after according to sentiment

analysis?

This study looks at news articles from popular US news media. I will investigate those questions on the basis of open-source news articles about Chinese international students in the ProQuest database spanning from 2017 to 2023. Focusing on the differences in topics before and after COVID-19, I will divide the news articles into two groups: 1) news articles before Jan.1, 2020, and 2) news articles after Jan.1, 2020. For each group of text, I will use a series of Natural Language Processing (NLP) tools and Structural Topic Modeling to analyze (Qaiser & Ali, 2018; Roberts, Stewart, & Tingley, 2019). Those NLP tools are previously used by many researchers for text mining (Lee, Kim, Nan, & Kim, 2021; Wu, 2021). This study will be focusing on Chinese students studying in the US, looking for differences in US news representations before and after the COVID-19 outbreak.

Related Work

As mentioned before, media portrayal of international students is a popular research topic. The aims are to provide information for universities and colleges to make changes to international students' policies and available resources, and also for future researchers studying more about media representations. Social media and news articles are excellent sources for this type of research.

News articles data is popular source of research for representations of international students. For example, researchers do explortory studies on news media to assess general attitudes towards Chinese international students. Anderson (2020) studies news media representations of international and refugee students in Canada. Drawing data from ProQuest databases, they apply thematic analysis on 391 popular news stream articles in Canada. The results show that international students and their influence are portrayed in contrasting ways in Canada: international students as assets vs. threats. Similarly, França (2020) investigates popular Portuguese press portrayals of international students. Using

the critical discourse analysis of 103 news articles from two Portuguese newspapers, França (2020) finds that international students are being portrayed positively as a creative group of skilled labor forces. Both studies provide insights for universities (in Canada and Portugal, but also other countries) to make changes to their policies for international students to prepare a more welcoming environment for international students.

Furthermore, comparative studies are also insightful in examining news representations of international students in the US. Particularly, Su and Borah (2021) focused on comparing representations of Chinese students studying in the US. Different from previously mentioned studies, the authors combined content analysis with statistical hypothesis tests to validate the differences between news media portrayals of Chinese international students. The results reveal that Chinese mainland media tends to view overseas Chinese students as victims and patriots, and US and Hong Kong media tends to view overseas Chinese students as liberalists and education seekers. Also, Xu (2022) conducted a study investigating comprehensive and critical news representations of Chinese international students. This study pioneered in comparing English-languaged news portrayals and Chinese-languaged news portrayals of Chinese international students. The results challenged common perceptions in English-languaged news articles of Chinese international students, and provided news perspectives on Chinese international students.

According to the related works above, it's obvious that studies of news representations of Chinese international students mainly used qualitative data analysis methods such as thematic analysis according to Braun and Clarke (2006)'s guide for thematic analysis. Computational text mining methods and natural language processing techniques, however, are hardly ever applied. Thus, to fill this research gap, I wish to use Structural Topic Modeling and Sentiment Analysis to investigate the news article coverage of Chinese international students in popular US news media.

As mentioned in the Introduction, Natural Language Processing Toolkit (NLTK) and

computational text analysis methods are widely used in text mining research. Various researches apply one or multiple computational text analysis methods For example, Wu (2021) used Topic Modeling to examine Chinese and US news media foci during the COVID-19 pandemic; Nguyen et al. (2020) explored shifts in Anti-Asian Sentiment on Twitter during the pandemic using Support Vector Machine (SVM); Choi and Kim (2013) used sentiment analysis with LIWC on Twitter data to explore when people are happier; and Lee et al. (2021) applied Structural Topic Modeling to more than 50,000 news articles on mask-wearing issues during the pandemic.

Moreover, although there are comparative studies on media portrayal of Chinese international students, most of them are comparing different news platforms or platforms in different countries (Su & Borah, 2021; Xu, 2022). Not a lot of comparative studies explored the differences in news representations across different time periods. Thus, in this study, I am interested in examining the differences in popular US news media portrayals of Chinese international students before and after the COVID-19 outbreak, particularly whether the COVID-19 outbreak has a negative effect on popular US news media portrayals of Chinese international students.

Data

This study uses a dataset downloaded from ProQuest. ProQuest is well-known for its information services, providing access to exhaustive ebooks, news articles, journal articles, and so on. It's commonly used by researchers conducting text-based studies (Anderson, 2020; Lam, Cunsolo, Sawatzky, Ford, & Harper, 2017; Thirumaran, Mohammadi, Pourabedin, Azzali, & Sim, 2021).

The news articles in this study are collected from six popular news publications in the US (both online and newspaper): *Boston Globe*, *Chicago Tribune*, *Los Angeles Times*, *New York Times*, *The Washington Post*, and *Wall Street Journal*. Searches using search

terms (shown in Table 1 are performed in all six news publications.

Table 1

Search Terms for Data Collections

Keywords
"International students" AND ("China" OR "Chinese")
"Chinese students" AND ("US" OR "U.S." OR "America")
"Chinese students" AND ("abroad" OR "overseas")

In total, 1525 articles (after removing duplicates) published from January 2017 to January 2023 are included, among which 741 articles were published before January 2020 (before the COVID-19 outbreak), and 784 articles were published after January 2020 (after the COVID-19 outbreak). The distribution of articles according to publications before and after the COVID-19 outbreak is shown in Table 2.

Most of the news articles are below 2000 words, except for only 4 articles exceeding 2000 words. Since there are only 4 articles with a length of more than 4000 words, I decided to remove those news articles for the convenience of Structural Topic Modeling applications. The distribution of news article lengths of articles with less than 2000 words is shown in Figure 1.

Methodology

Data Pre-Processing

I take the following steps to prepare and preprocess the dataset so that the text meet the requirement for text analysis.

Firstly, the articles downloaded from ProQuest are in text file format. So I extracted the article full text and other information using Python. Other information comprise of the

Table 2

Distribution of News Articles Published by Publications

Publication	Num of Articles (Before)	Num of Articles (After)
Boston Globe	56	47
Chicago Tribune	63	34
Los Angeles Times	103	53
New York Times	252	299
The Washington Post	149	190
Wall Street Journal	118	161
Total	741	784

authors, the subjects, the title, the publication title, publication date, publication year, location of publication of the articles. From the `publication date` and `publication year`, I created a new column `time_COVID` which classifies the news articles into two groups: 1) the ones published before the COVID-19 outbreak, and 2) the ones published after the COVID-19 outbreak. From the "publication title", I created a new column `publication` which grouped all publication titles into the six publications included.

Secondly, I pre-processed `full.text` of the article using Natural Language Processing Toolkit and the built in `textProcessor` in the `stm` R-package (Roberts et al., 2019). The pre-processing includes removing stop words, punctuation, numbers, words with less than 3 letters, and tokenizing and stemming all the words. The processed text are stored in a separate column `full_text_processed` in the dataset, and all topic modeling processes are done with the `full_text_processed` column.

Structural Topic Modeling

Firstly, all Topic Modeling methods are unsupervised quantitative text mining method to discover topics from text corpora, which depend on the two assumptions: 1)

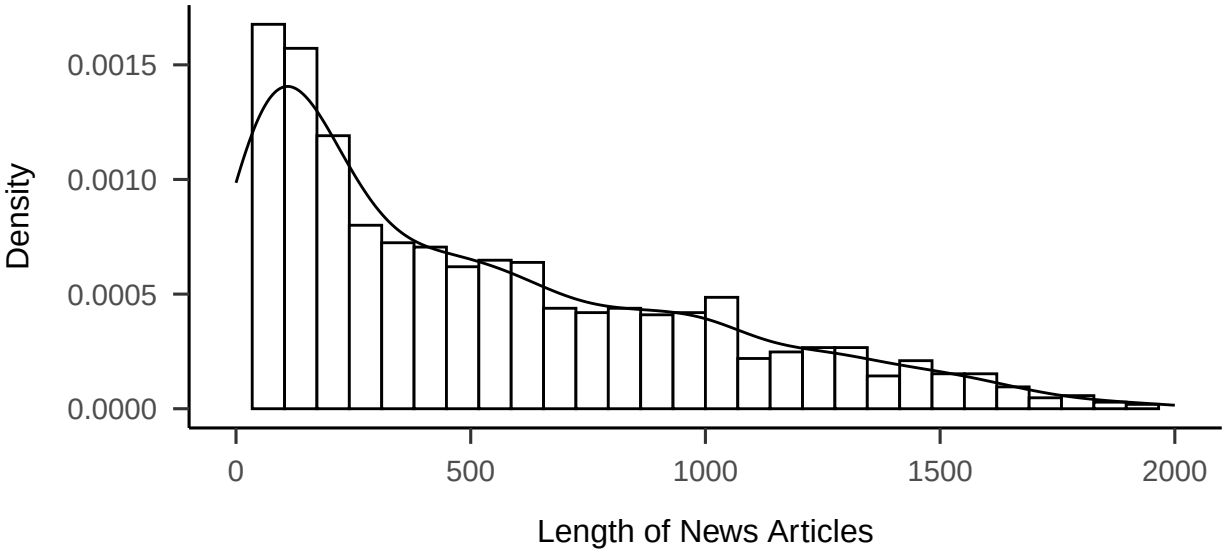

Figure 1. Distribution of News Article Lengths (with articles less than 2000 words)

each document (in this case, each news article) is a weighted mixture of different topics, and 2) each topic is a weighted mixture of different words. Figure 2 and figure 3 give a graphic example of two assumptions. In the example shown in the figures, the document consist of three topics: Sports, Health & Medicine, and Religion. And the Health & Medicine topic contains words such as "cancer", "vascular"; the Sports News topic contains words such as "baseball", "team". A topic can be contained in multiple documents, and a word can be contained in multiple topics as well (Ioana, 2020).

For instance, the Latent Dirichlet Allocation (LDA) Topic Modeling assumes both weighted mixtures obtain Dirichlet distributions. So the first assumed distribution of topics in documents is a Dirichlet distribution with parameter K, which is the number of topics, and parameter $\boldsymbol{\alpha}$, which is $\boldsymbol{\alpha_i}$ a vector of length K containing the weights of each topic in each document i. All entries of $\boldsymbol{\alpha_i}$ add up to 1 (Jelodar et al., 2019). I will use "document-topic distribution" to refer to this assumed distribution. The second assumed distribution of words in topics is also a Dirichlet distribution with parameter N, which is the number of words in the corpus, and parameter $\boldsymbol{\beta}$, which is $\boldsymbol{\beta_j}$ a vector of length N containing the weights of each word in each topic j. All entries of $\boldsymbol{\beta_j}$ also add up to 1

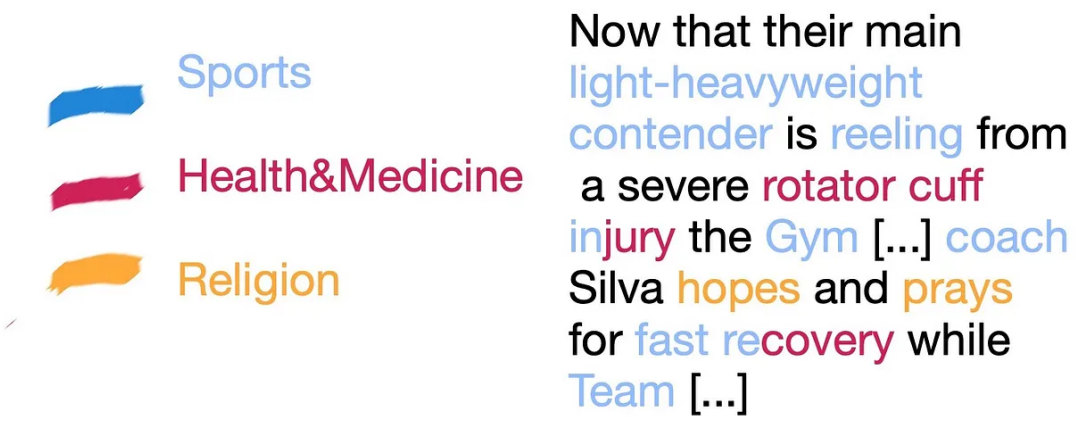

Figure 2. Example of a Document being a Weighted Mixture of Topics in Topic Modeling (Document-Topic Distribution). This figure is adapted from https://towardsdatascience.com/latent-dirichlet-allocation-intuition-math-implementation-and-visualisation-63ccb616e094

(Jelodar et al., 2019). I will use "topic-word distribution" to refer to this assumed distribution.

The LDA Topic Modeling workflow and where the Dirichlet distribution feed in is summarized in Figure 4. The topic-document distribution determine the proportion of each topic in each document, and together with the topic-word distribution, the algorithm put words to the generated document. Then, the algorithm compares the generated documents with the original ones and adjust the assumed distributions. This process is repeated until the closeness of the generated documents and the original documents reaches a threshold. The resulting topic-document distribution and topic-word distribution will then be used for further investigations.

In general, Structural Topic Modeling was built to construct a bridge between statistical methods and the research goals sociologists have, which is discover patterns in text data and find out relationships between those patterns (Roberts et al., 2019). A lot of

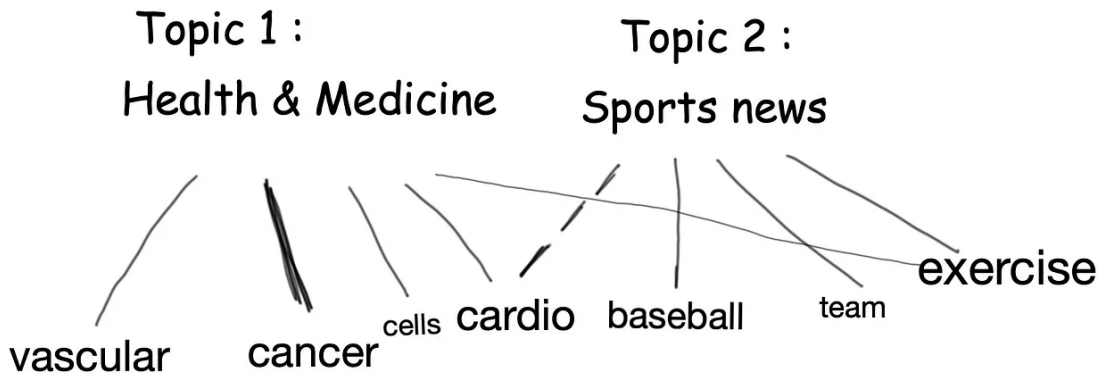

Figure 3. Example of Topics being Weighted Mixtures of Words in Topic Modeling (Topic-Word Distribution). This figure is adapted from https://towardsdatascience.com/latent-dirichlet-allocation-intuition-math-implementation-and-visualisation-63ccb616e094

research applied the Structural Topic Modeling technique for text analysis (Chandelier, Steuckardt, Mathevet, Diwersy, & Gimenez, 2018; Kwon, Chadha, & Wang, 2019; Lee et al., 2021).

The Structural Topic Modeling algorithm is an extension of the LDA Topic Modeling, which allows researcher to discover topics from text corpus and examine their relationship with corresponding covariates. Different from LDA, the weighted mixtures are not assumed to be Dirichlet distributions, but rather determined by the following assumptions, in which X_d is the covariates matrix for the topic-document distribution and y_d is the covariates matrix for the topic-word distribution. For more details, please refer to the generative process described in Section 2 of the journal article by Roberts et al. (2019). This article introduced Structural Topic Modeling and demonstrated its usage with the `stm` R package, which will also serve as a guidance for this study (Roberts et al., 2019).

In this study, I use the `stm` R package to perform Structural Topic Modeling on news articles with the covariate `time_COVID`, which classifies whether a news article is published

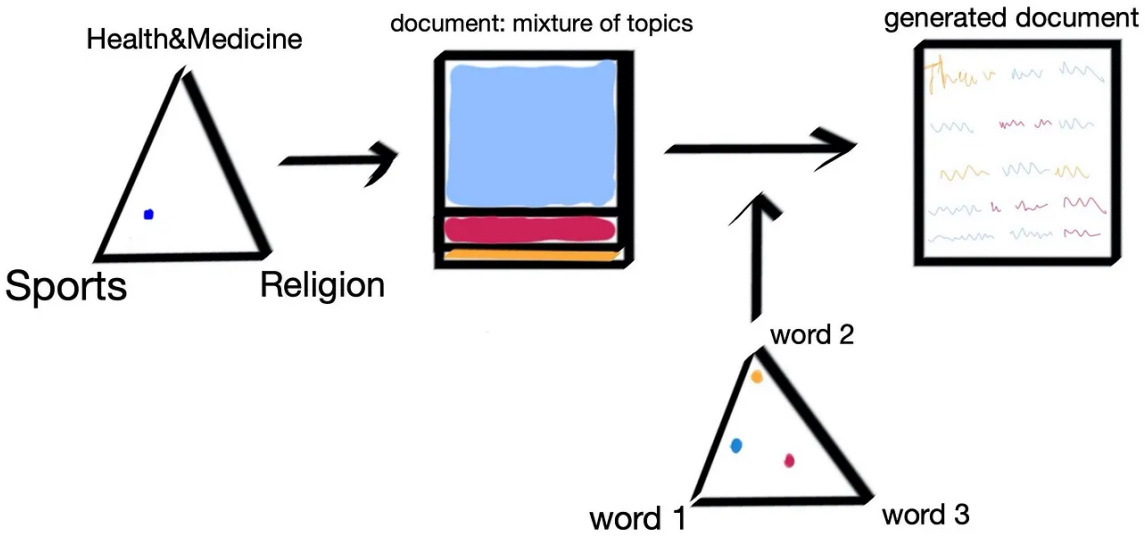

Figure 4. The LDA Topic Modeling Algorithm Graphically. This figure is adapted from https://towardsdatascience.com/latent-dirichlet-allocation-intuition-math-implementation-and-visualisation-63ccb616e094

before the COVID-19 outbreak or after the COVID-19 outbreak. The results of the topic model will answer the first research question: what are some topic changes before and after the COVID-19 outbreak? The procedure is described in Figure 5.

Sentiment Analysis – Linguistic Inquiry and Word Count (LIWC) & Two Sample *t*-Tests

To determine whether COVID-19 had a negative effect on news representations of Chinese international students, I conduct sentiment analysis on the articles with high proportion in each topic that is significantly associated with each time period. In this study, I use the Linguistic Inquiry and Word Count (LIWC) for sentiment analysis (Pennebaker, Boyd, Jordan, & Blackburn, 2015).

LIWC is a transparent text analysis software that counts words according to psychologically meaningful categories (Tausczik & Pennebaker, 2010). LIWC was first

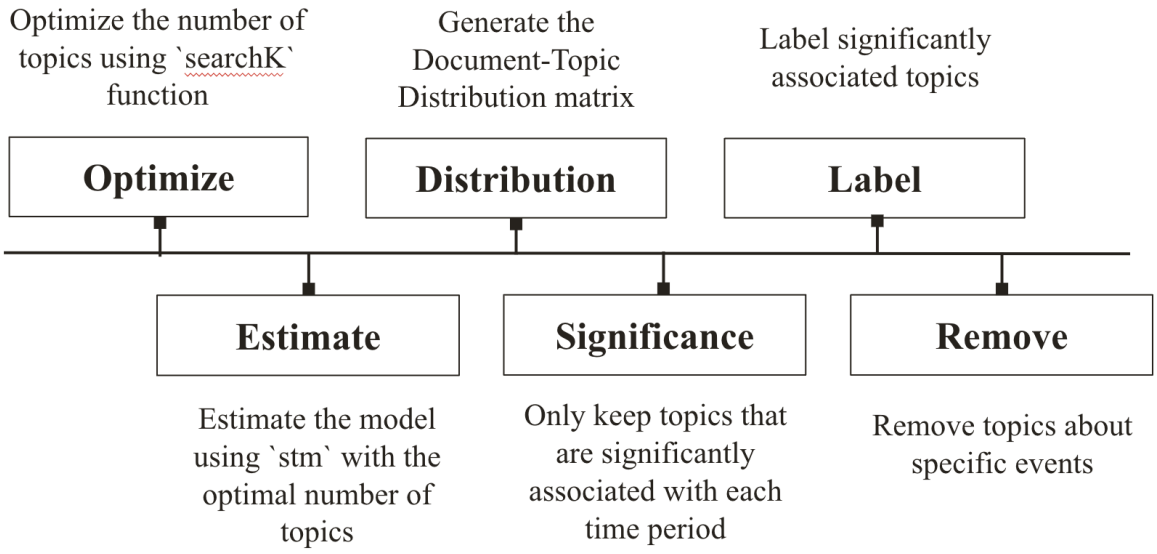

Figure 5. The Procedure Applying Structural Topic Modeling

developed in the 1980s based on the belief that words people in their lives contain tremendous amount of information about their emotions, thinking patterns, personalities, social relationships and so on. The software has two core components: the processing component and the dictionaries (Tausczik & Pennebaker, 2010). The processing component enables the software to read in text files. The dictionaries contain the categories a word can be associated with. In the LIWC2015 dictionary, there are over 80 categories including Affective Processes (whether a word contains positive emotion, negative emotion, or anger, anxiety, and so on), Social Process (whether a word is related to family, friends, or else), Time Orientations (whether a word focused more on the past, the present, or the future), etc. More details on the dictionaries' categories can be found in Table 1 of LIWC2015 Manual by Pennebaker et al. (2015).

In general, when plugging text files into LIWC, the software read each word in the document and search through the dictionary files. If the target word is matched with a dictionary word, the appropriate word category scale for that word is added. As the text file is being processed, counts for various structural composition elements (e.g., word count

and sentence punctuation) are also incremented. For each text file, a row of data including all categories and their corresponding scores is outputted (Pennebaker et al., 2015). The sentiment scores are evaluated mainly based on word counts.

In this study, I mainly focus on two sentiment scores: positive emotion (`posemo`) and negative emotion (`negemo`). Sentiment scores will be extracted from each article, and certain articles are selected according to the results of topic modeling. Then, two sample *t*-tests are conducted to compare whether there are significant mean differences. The general procedure is summarized in Figure 6.

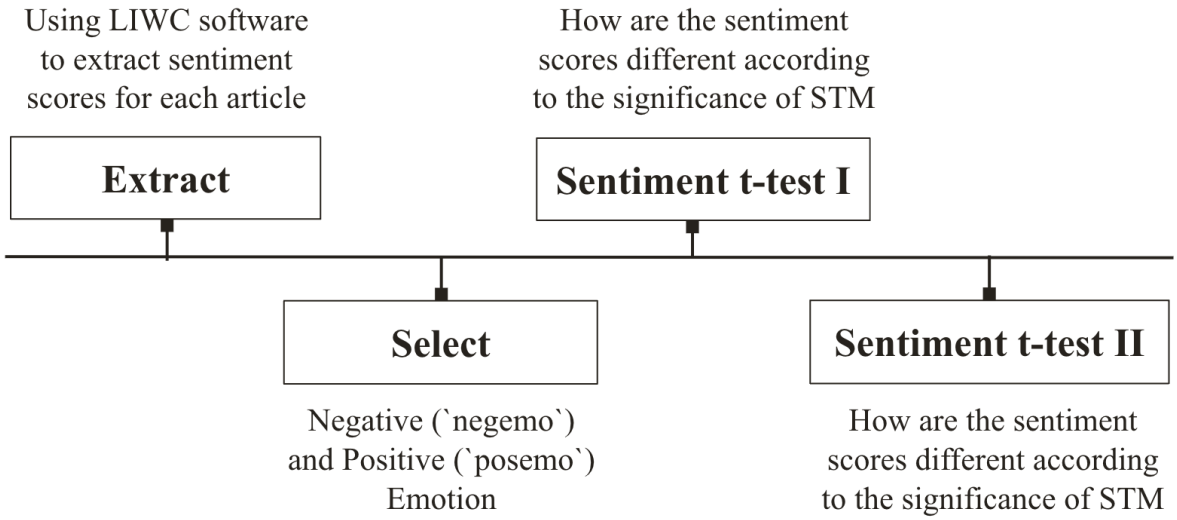

Figure 6. The Procedure Applying Sentiment Analysis and Two Sample t-tests

Results

Structural Topic Modeling

Following the steps listed in the Methodology section, I optimize the number of topics the dataset contains using the `searchK`. According to Figure 7, the topic model with 40 topics has the smallest residual. Thus, I choose to estimate the topic model using 40 topics. Using the top 50 words(stemmed) and the top 10 documents in each topic, I labeled

all the topics. Table 4 in the Appendix presents all the topics, its top 20 words, and the label I applied to the topic. The result of structural topic model with 40 topics are shown in Figure 8 with the expected proportion of each topic, and top 3 words that are associated with the topic.

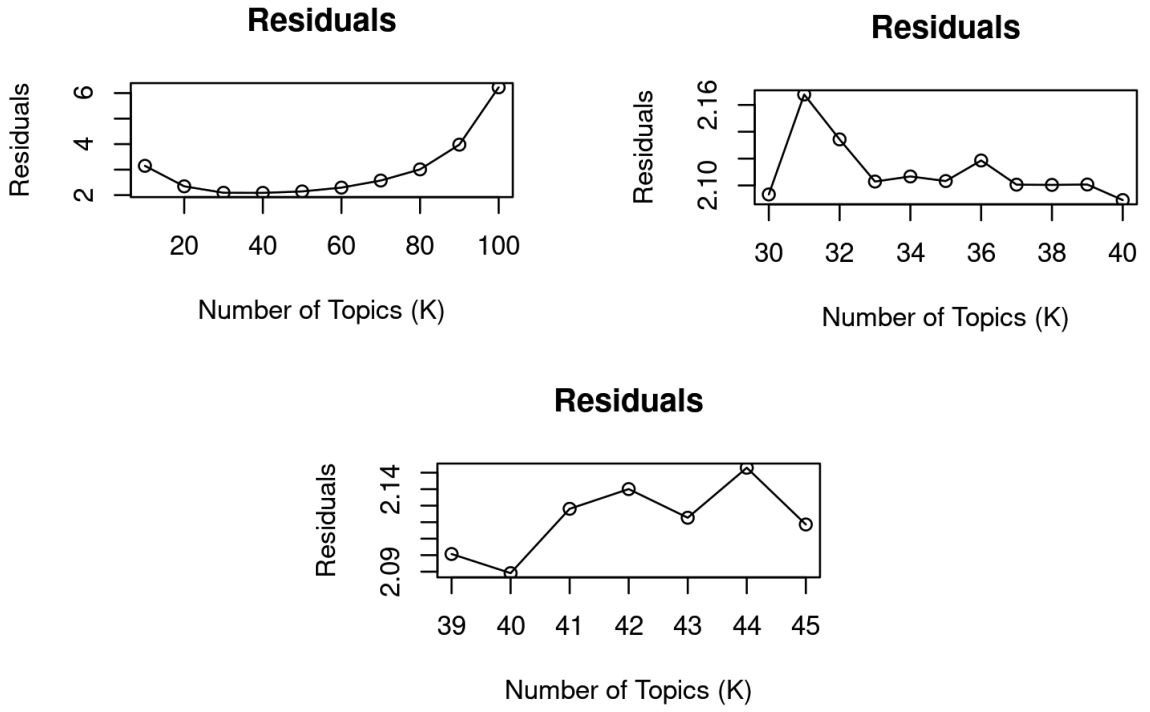

Figure 7. Residuals According Number of Topics

To further determine which topics are associated with each time period (either before the COVID-19 outbreak or after the COVID-19 outbreak), I use the `estimateEffect` function to estimate the coefficient estimates and the p-value for each topic. With "before" as the baseline level, Figure 9 provides a graphical view of the coefficient estimates (for the "after" level) and whether a topic is leaning more towards one time period or the other. For more details, Tables 3 in the Appendix shows the coefficients estimate (for the "after" level) and p-values for each topic.

With $\alpha = 0.05$ as the significance level, topics 2, 3, 4, 5, 8, 9, 11, 37, 40 is statistically associated with the "before" time period, and topics 10, 14, 23, 24, 25, 35 is statistically

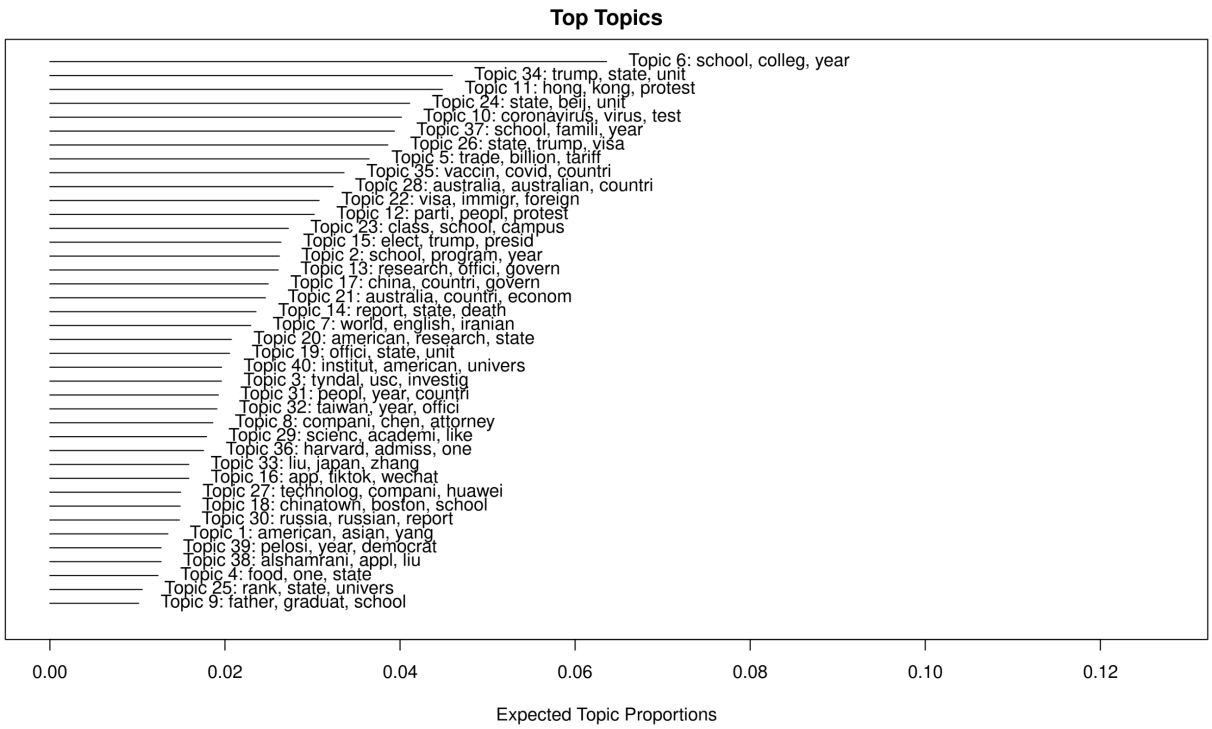

Figure 8. Topic Proportions and Words Associated with Topics

associated with the "after" time period. Figure 10 summarizes the coefficient estimates (for the "after" level) and the labels of all significant topics associated with each time period. According to the topic labels, I decide to remove topics 3, 4, 9, 11, 25 since they are about specific cases that taken place in those two time periods, which won't help with the study. Figure 11 summarizes the coefficient estimates (for the "after" level) and the labels of all remaining significant topics.

According to the topic modeling results, academic and education related topics are mentioned more during the time period before the COVID-19 outbreak. Topics about resolving challenges and issues are the main focus of the time period after the COVID-19 outbreak. Also, there's generally more diverse significant topics during the time period before COVID than after COVID.

Also, I extract the document-topic distribution matrix according to the topic model. Those proportions are used to determine the articles that are associated with each

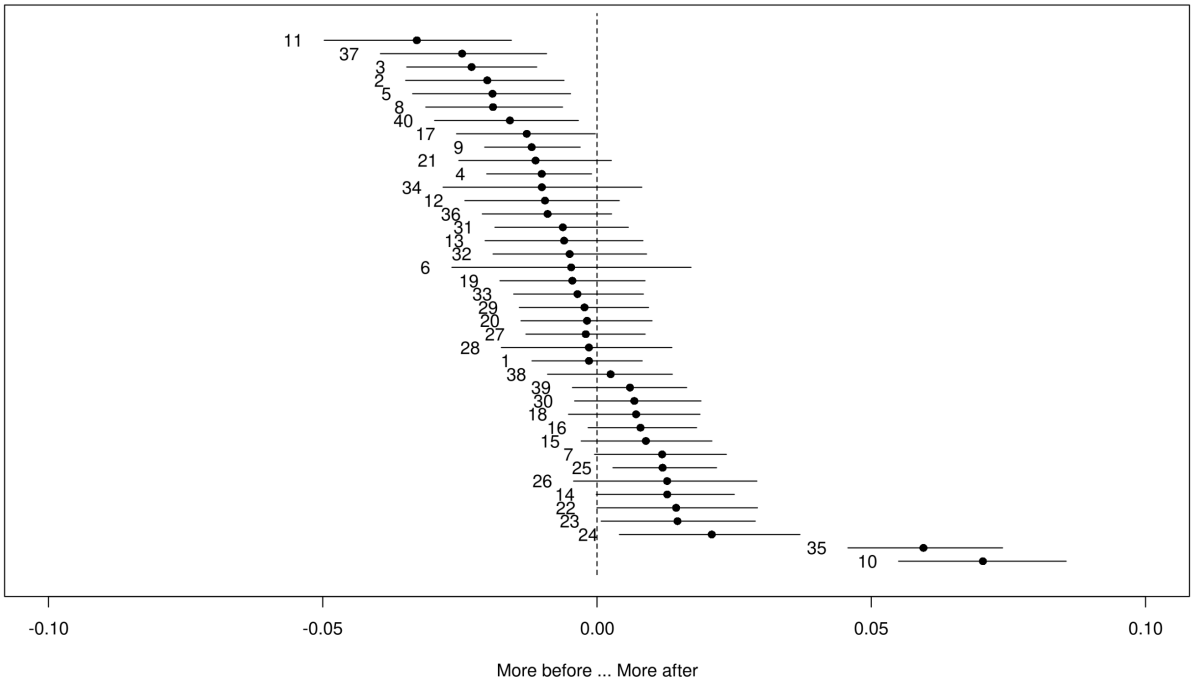

Figure 9. Graphical View of Coefficient Estimates

significant topics. Figure 12 shows the distribution of the highest topic proportions each document contains. Most documents' highest topic proportion is over 0.5. Thus, although each document is a mixture of topics, each topic is represented by 1-3 topics.

LIWC Sentiment Analysis & Two Sample *t*-Tests

Based on the results from topic modeling, topics 2, 5, 8, 37, 40 are significantly associated with the time period before the COVID-19 outbreak, which I refer to this group of topics "before significant articles". Topics 10, 14, 23, 24, 35 are significantly associated with the time period after the COVID-19 outbreak, which I refer to this group of topics "after significant articles". Then, for those two groups of topics, articles with a proportion greater than or equal to 0.5 was selected. 140 articles are included for significant topics before COVID, and 196 articles are included for significant topics after COVID.

By applying LIWC sentiment analysis on the dataset, each news article is assigned

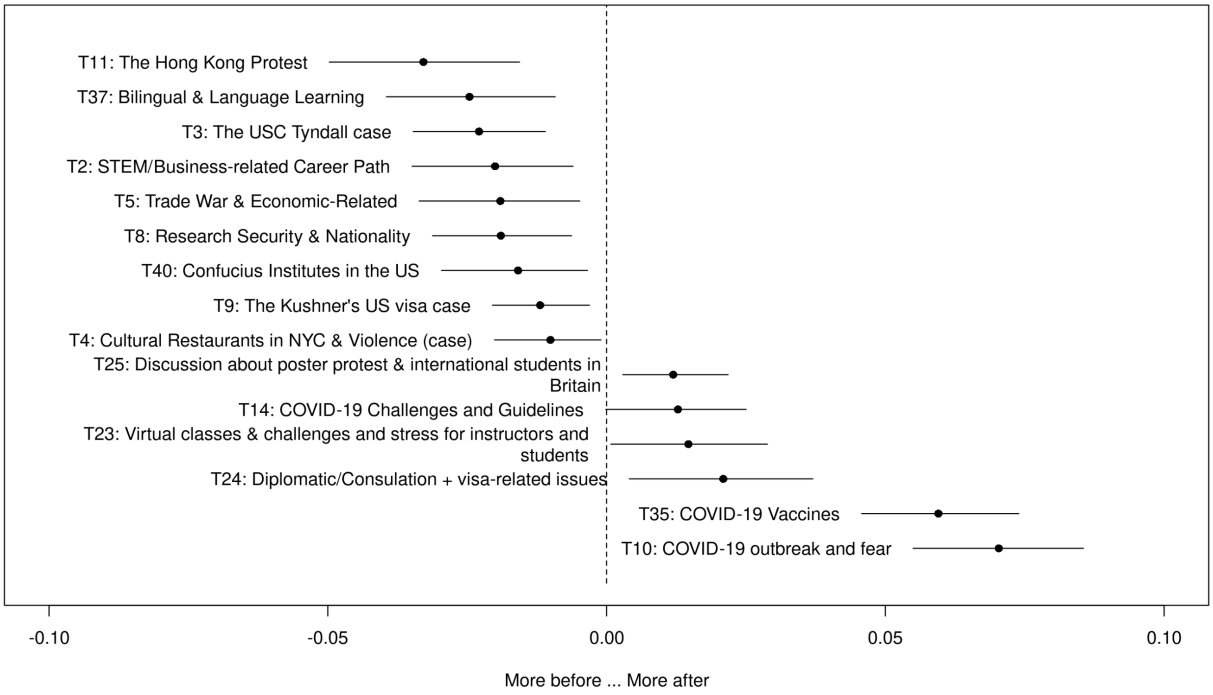

Figure 10. Coefficient Estimates for Significant Topics

with a vector of sentiment scores. In this study, I am interested in the differences of the average of positive emotion scores (`posemo` column) and the average of negative emotion scores (`negemo` column) between "before significant articles" and "after significant articles".

Figure 13 presents the boxplots that compares the positive and negative emotion scores for the two groups after removing outliers. By the two sample t-test, there's a statistically significant difference in the average of positive emotion scores between articles in "before significant articles" and "after significant articles" ($p = 0.0008637$). However, the average of negative emotion scores between articles in "before significant articles" and "after significant articles" are statistically significant ($p = 0.196$).

Topics 1, 6, 13, 15, 16, 17, 20, 22, 26, 34 are not addressing specific cases and are not significantly associated with neither time period (Table 4 in the Appendix shows the topics and their labels). Articles with a proportion greater than or equal to 0.5 are extracted for those topics as well. The articles are split into two groups according to the `time_COVID`

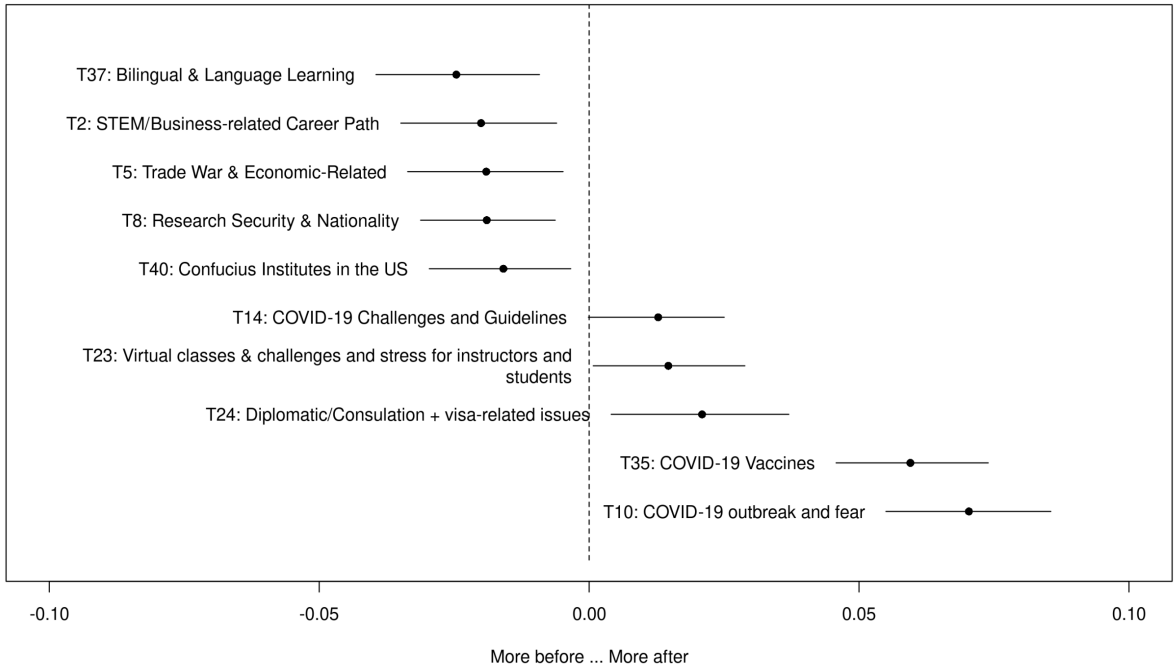

Figure 11. Coefficient Estimates for Significant Topics

column, which I refer to the "before non-significant articles" and "after non-significant articles". 157 articles are included in "before non-significant articles" group, and 164 articles are included in "after non-significant articles" group.

Similarly, I aim to compare the differences of the average of positive emotion scores (`posemo` column) and the average of negative emotion scores (`negemo` column) between "before non-significant articles" and "after non-significant articles". Figure 14 presents the boxplots that compares the positive and negative emotion scores for the two groups after removing outliers. Based on the two sample t-tests, neither the average of positive emotion scores nor the average of negative emotion scores between articles in "before non-significant articles" and "after non-significant articles" are statistically significant ($p = 0.09637$ and $p = 0.6487$).

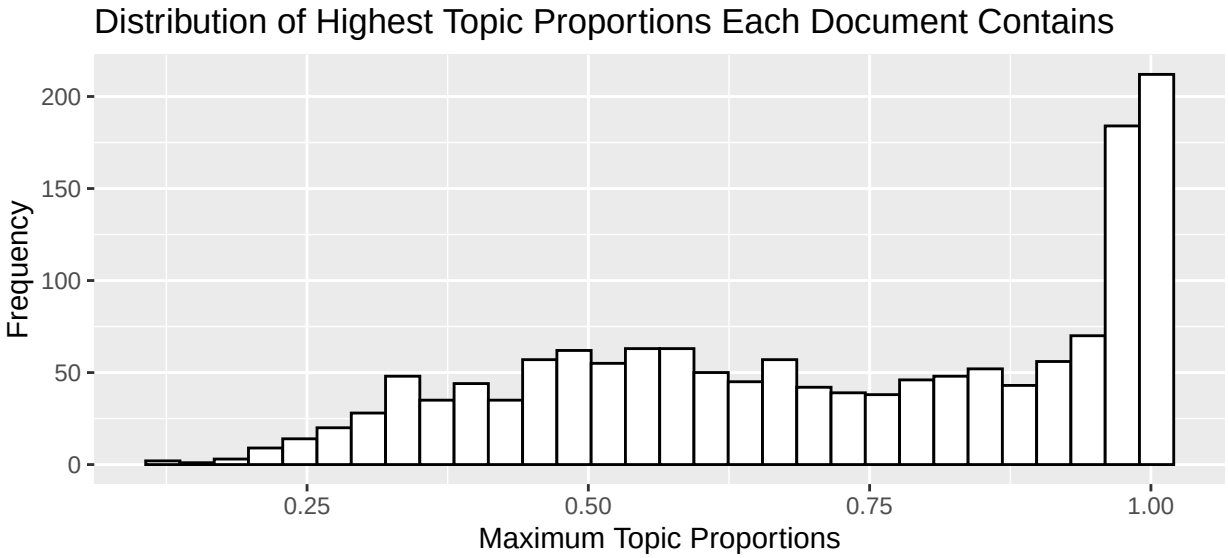

Figure 12. Distribution of Highest Topic Proportions Each Document Contains

Discussion

Conclusion

According to the results from structural topic modeling, topics foci for Chinese international students changed after the COVID-19 pandemic. Significant topics before the COVID-19 outbreak mainly focused on educational/academic developments of Chinese international students. For example, topic 2 discusses career options for STEM or Business related majors, and topic 37 discusses language learning among international students. This result is not surprising as Chinese international students are portrayed popularly as liberal education seekers (Abelmann & Kang, 2014; Anderson, 2020; França, 2020; Su & Borah, 2021). However, significant topics after the COVID-19 outbreak shares a common theme of overcoming challenges. For instance, topic 23 addresses the challenges and stress for instructors and international students doing virtual classes, and topic 35 discusses issues related to the COVID-19 vaccines and how Chinese international students are getting vaccinated and approved to return school by US institutions. It's not hard to notice that health related issues concern Chinese international students after COVID-19.

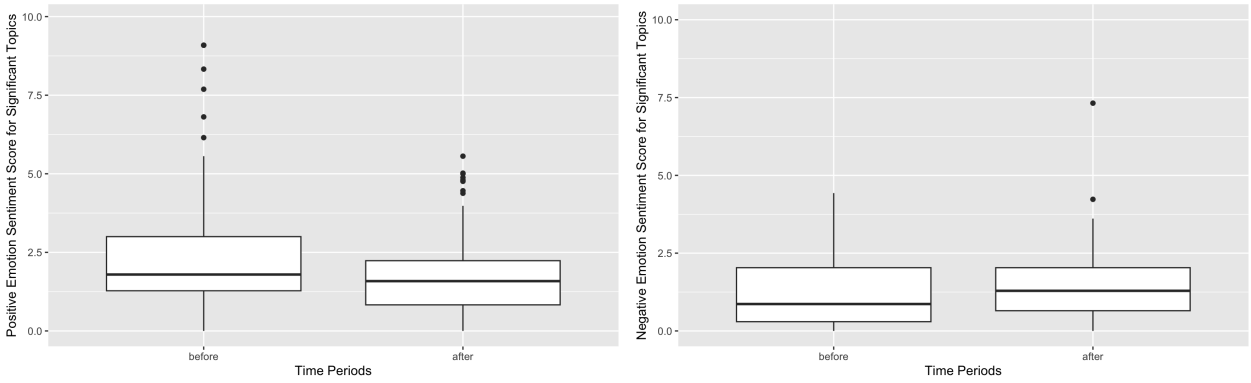

Figure 13. The Average Differences in Positive and Negative Emotion Scores between Two Significant Topic Groups

Also, with the influences of the pandemic, more challenges such as visa issuing and travelling constraints arise for Chinese international students.

Based on the sentiment analysis and two sample t-tests on the articles from the significant topics, there's a statistically significant mean difference for the positive emotions score. This result provide evidence that the news representations for Chinese international students were more positive before the COVID-19 outbreak. The findings from topic modeling also matches with this result. Articles about education seeking and academic developments contains more positive sentiments than articles about resolving issues and overcoming challenges. On the other hand, none of the average emotions scores differences were significant between articles in the non-significant topics. This indicates that for topics that has been discussed in the news for both time periods, there's no statistically significant changes in the sentiment scores.

Also, it's worth noticing that there's no topics that general discusses issues with discrimination and racism against Chinese international students except for a few case topics. Thus, even though postings related to racism, discrimination, and "Asian hate" against China and Chinese international students increased in social media and news (Gao, 2022; Nguyen et al., 2020; Zhang & Trifiro, 2022), they might not be noticeable through

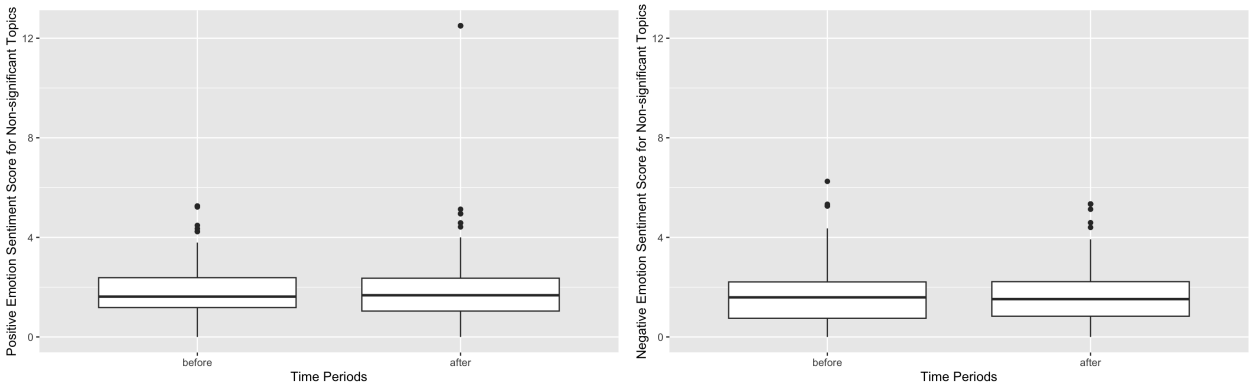

Figure 14. The Average Differences in Positive and Negative Emotion Scores between Two Non-significant Topic Groups

topic modeling. Another explanation to this result is that news media representations might not be as sentimental as social media representations such as Twitter posts. Thus, future studies on social media data might provide new insights to comparing media representations of Chinese international students across different time periods.

Limitations

This study applied structural topic modeling and sentiment analysis methods on news articles to investigate the changes between news portrayals of Chinese international students before and after the COVID-19 outbreak. Although generally sound, it's worth examining the limitations of this study.

Firstly, the dataset used in this study contains 1521 news articles, which is one of the limitations. Also, according to Figure 1, although articles with more than 2000 words was removed from the dataset, the distribution of article lengths is still not the best to apply structural topic modeling.

Secondly, the two time periods (before vs. after the COVID-19 outbreak) I compared were separated by a single date. There's no gaps between two time periods. As the COVID-19 pandemic developed over a few months, this limitation might count for

non-significant changes in sentiments between the two time periods.

Thirdly, the text mining and natural language processing methods I use, Structural Topic Modeling and LIWC, are "black box" methods. There are both computationally heavy methods that are complicated to validate. Structural Topic Modeling and LIWC have been applied in many other researches, providing fruitful insights using text data (Lee et al., 2021; Nguyen et al., 2020; Wu, 2021). However, it's worth noting that the validity of those methods are still upon discussions. On the other hand, the process of labeling and removing topics in this study are human activities, even though I have read the top 10 articles and top 50 words for each topic. Different researchers might have different opinions on the process of labeling and removing topics.

Future Directions

Regarding the studies about news representations of Chinese international students, I provide some future research directions worth studying.

Firstly, comparative studies of Chinese-languaged news on overseas Chinese students would be interesting. Inspired by Xu (2022), new perspectives of Chinese international students were found in Chinese-languaged news. Together with this study, we may compare the differences between news representations in English and in Chinese of Chinese international students.

Secondly, social media portrayals of Chinese students in the US is also a compelling research topic. Besides popular news media, people also tend to seek information for popular social media platforms, especially during the COVID-19 pandemic (Kožuh & Čakš, 2021; Schulz, Fletcher, & Nielsen, 2022). Also, as mentioned before, news media representations might not be as sentimental as social media representations. Thus, understanding social media portrayals of Chinese international students may provide new perspectives of topic changes before and after the COVID-19 outbreak.

Thirdly, besides the COVID-19 outbreak, there are other significant events that influences news representations of Chinese international students. For example, the president election in 2020 and the trade war beginning in 2018 appeared to shift a lot of policies regarding visa issuing and travelling between China and the US. Comparative studies examining the differences in news representations of overseas Chinese students before and after other significant events are also worth conducting.

Appendix

Table 3

Coefficient Estimates (after) and p-values for Topics

Topic	Coefficient Estimate (after)	p-value
1	-0.0014240	0.78
2	-0.0200420	0.00705
3	-0.0227780	0.000149
4	-0.0101370	0.0352
5	-0.0191380	0.00866
6	-0.0045860	0.677
7	0.0116840	0.053045
8	-0.0190090	0.00332
9	-0.0118970	0.00743
10	0.0701217	<2e-16
11	-0.0326490	0.000189
12	-0.0096990	0.195
13	-0.0059510	0.411
14	0.0128530	0.04282
15	0.0090130	0.137
16	0.0079150	0.119215
17	-0.0127080	0.0554
18	0.0071060	0.22352
19	-0.0044570	0.508
20	-0.0019850	0.75
21	-0.0113020	0.107
22	0.0143870	0.0607

23	0.0146260	0.037528
24	0.0208920	0.0129
25	0.0118910	0.0125
26	0.0125080	0.146
27	-0.0019300	0.731
28	-0.0015990	0.841
29	-0.0023120	0.705
30	0.0066720	0.24104
31	-0.0062460	0.311
32	-0.0049250	0.49
33	-0.0036370	0.541
34	-0.0100450	0.284
35	0.0597290	4.06e-16
36	-0.0091930	0.119
37	-0.0245630	0.00145
38	0.0022930	0.68859
39	0.0060350	0.254519
40	-0.0158200	0.0169

Table 4

Labels and Top 50 Words of Topics Associated

Topic	Label	Top 50 Words

1	Stereotype & Candidacy and voting	american, asian, yang, democrat, one, stereotyp, immigr, work, peopl, say, even, debat, educ, italian, vote, state, bill, isnt, day, countri, mani, presid, polit, use, experi, need, make, also, way, year, usc, presidenti, know, noncitizen, math, citi, see, univers, good, doctor, studi, realli, part, success, call, support, incom, suggest, group, comment
2	STEM/business-related grad school or career path	school, program, year, applic, busi, graduat, countri, degre, declin, mba, work, canada, immigr, stay, visa, administr, number, accord, percent, colleg, data, mani, manag, increas, unit, report, state, chang, last, polici, univers, recent, pathway, american, make, canadian, top, stem, want, one, dean, educ, among, scienc, includ, studi, recruit, northeastern, job, foreign
3	The USC Tyndall case	tyndal, usc, investig, report, complaint, patient, gynecologist, doctor, one, former, state, comment, day, person, clinic, women, exam, medic, woman, also, center, physician, accus, say, accord, shoot, train, lieuten, campus, sexual, alshamrani, sever, abus, statement, week, american, saudi, year, offici, offic, health, includ, angel, time, los, come, spoke, kill, receiv, incid

4	Cultural Restaurants in NYC & Violence (case)	food, one, state, asian, indonesian, american, open, indonesia, restaur, cabl, even, kill, still, note, document, columbia, anoth, unit, first, militari, reader, mani, suharto, govern, manhattan, member, parti, black, talk, area, event, peopl, communist, depart, call, west, began, junzi, south, power, held, general, support, locat, grew, hit, show, polit, public, releas
5	Trade War & Economic-Related	trade, billion, tariff, year, good, export, product, compani, busi, import, includ, deal, last, econom, trump, firm, market, invest, industri, deficit, say, american, countri, sector, administr, accord, offici, purchas, reduc, also, expect, insur, manufactur, want, investor, agreement, servic, global, tri, buy, get, percent, world, america, growth, steel, sale, work, commerc, sign
6	Financial or tuition & standard testing for higher education institutions	school, colleg, year, enrol, educ, univers, state, number, fall, campus, institut, foreign, tuition, accord, last, declin, percent, studi, mani, admiss, countri, unit, increas, presid, drop, test, american, come, report, also, take, program, pandem, higher, like, high, class, financi, million, one, revenu, india, even, pay, travel, may, get, applic, make, academ

7	Keon apologize for mocking Asian languages case	world, english, iranian, cultur, global, countri, angel, los, iran, peopl, american, one, educ, women, learn, true, speak, much, mani, leader, purdu, school, tradit, languag, govern, import, california, nation, citi, valu, back, word, idea, keon, seem, live, time, compani, made, state, well, san, like, histori, communiti, economi, econom, connect, help, told
8	Research security related to nationality	compani, chen, attorney, custom, prosecutor, alleg, state, charg, express, suburban, statement, lawsuit, also, offic, govern, general, madigan, case, illinoi, busi, feder, initi, year, file, arrest, email, inform, oper, peopl, order, serv, bus, post, investig, like, polici, servic, chicago, countri, accord, toeppen, english, accus, agreement, agent, fals, various, court, reach, websit
9	The Kushner's US visa case	father, graduat, school, compani, mother, park, also, receiv, law, degre, groom, coupl, retir, famili, son, firm, sept, daughter, met, marri, project, collect, busi, work, manag, offici, high, program, qiaowai, colleg, invest, partner, state, master, associ, friend, presid, privat, late, cathol, former, thoma, ding, art, american, washington, date, chief, chicago, million
10	COVID-19 outbreak and fear	coronavirus, virus, test, outbreak, travel, peopl, offici, health, state, countri, wuhan, case, infect, govern, one, spread, school, day, campus, south, home, death, week, diseas, flight, unit, citi, two, center, number, korea, return, worri, recent, quarantin, year, take, also, restrict, american, cancel, face, even, march, back, arriv, mask, time, world, asian

11	The Hong Kong Protest	hong, kong, protest, polic, mainland, school, beij, demonstr, citi, support, week, govern, one, call, peopl, china, media, campus, offici, australia, high, recent, movement, use, group, organ, social, two, street, even, say, like, appear, includ, ralli, plan, law, violenc, author, last, nation, freedom, right, activist, warn, face, take, show, clash, attack
12	The Tiananmen Square Protest	parti, peopl, protest, communist, beij, one, polit, squar, tiananmen, leader, media, use, mani, social, photo, year, govern, like, first, countri, even, account, demonstr, ideolog, day, author, imag, onlin, state, offici, may, sinc, also, man, power, young, post, nation, china, take, crackdown, call, educ, teacher, critic, world, slogan, bridg, poster, seen
13	Research security and justice & foreign influence on US research	research, offici, govern, univers, institut, depart, scientist, academ, american, work, fund, investig, case, visa, nation, technolog, agenc, school, nih, feder, professor, fbi, foreign, program, report, administr, collabor, scienc, mit, accord, one, inform, state, health, target, secur, justic, tie, unit, militari, disclos, grant, concern, warn, public, scientif, scholar, studi, espionag, say
14	COVID-19 spread and state-based challenges and guidelines	report, state, death, case, trump, week, day, peopl, virus, record, american, pandem, hous, presid, coronavirus, test, school, nation, includ, offici, counti, feder, republican, mask, saturday, white, number, california, administr, even, million, say, april, also, social, data, friday, announc, top, call, health, move, order, packag, tuesday, requir, end, first, wear, need

15	President election related: campaigning and voting	elect, trump, presid, state, vote, polit, republican, biden, also, democrat, pandem, campaign, presidenti, voter, work, report, parti, coronavirus, ballot, next, year, mail, nation, week, effort, say, american, hous, support, offici, includ, tri, secur, pompeo, govern, public, even, plan, poll, leader, peopl, request, call, insid, cybersecur, offic, mani, system, view, issu
16	Permissions/bans for apps developed by tech industries in different countries	app, tiktok, wechat, trump, compani, administr, user, american, britain, move, china, european, million, govern, presid, bank, data, month, financi, one, show, platform, ban, beij, union, like, technolog, london, use, busi, may, coronavirus, secur, make, even, popular, research, hold, loan, social, report, design, deal, access, found, decoupl, financ, build, univers, last
17	Attitudes of Chinese people/government towards overseas Chinese students	china, countri, govern, year, one, like, peopl, polit, abroad, guo, beij, western, home, recent, mani, educ, public, chang, internet, right, also, return, even, say, patriot, studi, oversea, nation, million, unit, global, around, articl, power, back, onlin, day, presid, time, world, fear, state, censorship, foreign, month, use, american, today, move, show
18	Boston Chinatown restaurant money laundering operations case	chinatown, boston, school, year, peopl, chang, court, children, first, citi, neighborhood, associ, umass, found, help, also, lee, mother, white, work, street, mrs, restaur, communiti, american, like, parent, liu, one, buse, time, made, presid, two, organ, black, committe, take, resid, famili, immigr, asian, open, becam, bring, moy, day, end, didnt, come

19	The case with China arresting and freeing the two canadians Spavor and Kovrig	offici, state, unit, peopl, nation, group, secur, govern, canada, canadian, charg, depart, two, meng, foreign, case, initi, ajjawi, asian, face, arrest, beij, justic, famili, american, detain, kovrig, take, attack, michael, effort, last, concern, countri, south, right, friday, media, spokesman, like, report, prosecutor, huawei, espionag, campus, month, detent, work, garcia, wrote
20	AI and high tech development & threat and spy related problems	american, research, state, unit, univers, technolog, work, nation, scientist, year, mani, america, studi, compani, countri, feder, recent, increas, peopl, one, scienc, institut, innov, fear, academ, graduat, help, threat, secur, engin, intellig, militari, includ, last, talent, say, espionag, also, china, economi, charg, educ, ethnic, field, found, scholar, committe, administr, center, number
21	Crisis with the Australian labor government (case)	australia, countri, econom, economi, state, unit, australian, nation, china, quarter, foreign, one, world, trade, canada, today, global, trump, beij, week, polit, two, presid, year, last, put, report, also, growth, mani, larg, labor, govern, war, prime, american, minist, system, leader, keep, reagan, tie, well, asian, get, may, america, asia, made, decad
22	Immigration and visa related after graduation: H1b, OPT, working visa, etc.	visa, immigr, foreign, countri, year, worker, work, american, program, compani, state, restrict, trump, unit, job, busi, graduat, administr, mani, pandem, like, employ, japan, limit, nation, execut, peopl, univers, canada, last, also, order, issu, studi, say, come, opt, make, govern, presid, includ, accord, allow, plan, econom, time, remain, travel, need, ban

23	Virtual classes & challenges and stress for instructors and students	class, school, campus, onlin, year, program, mani, get, work, stay, cost, need, semest, home, colleg, peopl, spring, virtual, break, plan, learn, time, busi, pandem, even, fall, mooncak, want, take, offer, teach, live, pay, also, two, regent, like, help, english, make, meet, mit, one, first, tuition, studi, hope, come, abl, faculti
24	Diplomacy consulation & visa related issues	state, beij, unit, parti, offici, govern, china, consul, foreign, diplomat, japan, two, administr, nation, countri, also, american, member, relat, secur, trump, year, hong, communist, kong, depart, washington, action, econom, houston, presid, trade, influenc, includ, visit, polici, war, ministri, issu, travel, one, visa, move, peopl, meet, close, respons, effort, world, polit
25	Discussion about poster protest & international students in Britain	rank, state, univers, wrighton, world, visa, peopl, list, poster, year, britain, govern, unit, top, imag, includ, presid, british, institut, graduat, want, school, leader, countri, offer, global, program, faculti, campus, pandem, also, high, plan, critic, gwu, understand, get, well, research, polici, put, colleg, say, interim, technolog, two, see, mani, centuri, call
26	Trump's policy with visa & immigration	state, trump, visa, unit, colleg, polici, administr, countri, univers, presid, immigr, school, studi, ban, harvard, offici, class, educ, rule, depart, order, american, mani, onlin, institut, campus, year, foreign, travel, peopl, also, includ, issu, feder, affect, last, back, plan, week, fall, nation, one, allow, percent, health, higher, announc, accord, effect, attend

27	Chinese spies accused of using Huawei in secret Australia telecom hack (case)	technolog, compani, huawei, state, american, unit, use, govern, quantum, secur, world, research, googl, one, data, nation, also, mani, network, countri, year, china, comput, firm, big, like, busi, move, make, pan, peopl, digit, communic, beij, depart, work, come, two, concern, inform, trump, develop, invest, much, softwar, administr, center, report, access, facebook
28	Australian prime minister (case)	australia, australian, countri, year, sydney, govern, pandem, kummerow, one, beij, coronavirus, like, polit, influenc, say, also, investig, minist, support, first, foreign, call, mani, prime, month, day, case, pavlou, public, immigr, sinc, recent, issu, last, canberra, world, econom, offici, work, economi, border, letter, global, two, growth, nation, professor, paper, end, effort
29	Film studies and Feirstein graduate school of cinema (case)	scienc, academi, like, nation, school, year, one, film, presid, carter, state, two, also, world, scientif, unit, shiffrin, burk, ski, among, govern, technolog, thing, research, work, time, scientist, train, includ, earth, studi, american, serv, make, lot, chou, music, peopl, way, countri, institut, think, brooklyn, feirstein, frank, columbia, mountain, war, say, develop

30	Russia and China further building bridges as Ukraine war hits (case)	russia, russian, report, china, countri, nation, talent, program, technolog, state, work, also, recruit, unit, year, research, last, scientist, militari, includ, return, accord, station, secur, part, data, beij, offici, moscow, intellig, told, strategi, peopl, mani, compani, associ, one, top, citadel, polit, shi, govern, citi, polic, foreign, ukrain, run, two, river, depart
31	US-Japan Relationship & several cases	peopl, year, countri, mani, japan, state, want, need, email, two, unit, govern, one, think, ask, japanes, health, world, mental, relationship, studi, visitor, help, say, professor, bad, like, neeli, tourist, make, view, thing, visit, tri, school, past, work, boalt, last, law, public, concern, graduat, part, parti, know, question, also, wrote, member
32	Taiwan's military ties to Singapore targeted by China case	taiwan, year, offici, unit, state, teng, militari, nation, defens, singapor, one, american, countri, two, also, island, govern, mani, beij, visit, washington, help, cultur, stori, move, blockad, say, recent, forc, like, exercis, call, orchestra, time, oversea, becom, singaporean, peopl, work, taiwanes, wang, compani, scholar, group, first, polit, program, part, last, includ

33	Liu Jingyao case	liu, japan, zhang, busi, case, countri, border, travel, court, famili, one, christensen, minneapoli, sinc, dinner, month, file, trial, indonesia, accord, execut, hope, world, pandem, say, richard, accus, close, tokyo, minnesota, reopen, also, sexual, rape, charg, start, hiros, whether, arrest, program, yingi, like, tourist, statement, polic, illinoi, day, campus, come, variant
34	Trade war & war policies by Obama vs. Trump	trump, state, unit, american, presid, administr, polici, trade, beij, world, war, countri, technolog, econom, like, offici, chang, economi, america, iran, also, mani, china, foreign, deal, govern, one, two, nation, washington, make, last, regim, relat, action, agreement, pressur, recent, power, way, even, biden, relationship, issu, first, part, forc, global, practic, intellectu
35	Discussion about COVID-19 vaccines	vaccin, covid, countri, peopl, health, offici, travel, coronavirus, control, year, pandem, world, infect, one, get, border, month, mani, china, virus, accord, two, quarantin, use, case, week, test, public, trial, close, still, lockdown, data, last, expert, singapor, recent, live, hospit, nation, citi, approv, compani, popul, open, emerg, sign, effect, start, develop

36	Trail investigating whether Harvard discriminates against Asian-Americans case	harvard, admiss, one, year, asian, school, fitzsimmon, offic, asianamerican, earli, like, beckel, high, call, applic, india, recent, counti, admit, chong, long, way, colleg, time, sat, divers, race, friend, graduat, offici, also, realli, polit, often, citi, later, along, want, score, home, develop, class, irvin, open, orang, democrat, test, show, parent, number
37	Bilingual standard & language learning in general	school, famili, year, parent, children, home, live, two, first, educ, high, get, also, learn, kid, colleg, languag, want, american, studi, peopl, like, help, day, attend, state, work, time, friend, america, mother, ken, unit, host, experi, make, life, english, start, son, take, come, one, room, hous, way, place, cultur, competit, reason
38	Pensacola Gunman and AI Qaeda case	alshamrani, appl, liu, phone, year, one, qaeda, shoot, secur, law, attack, offici, compani, militari, travel, investig, help, wray, govern, last, barr, hous, group, enforc, access, pensacola, saudi, public, depart, famili, accus, case, two, time, show, fbi, settlement, state, oper, train, thanksgiv, foreign, home, like, iphon, allow, messag, import, area, store
39	Pelosi's Trip to Taiwan case	pelosi, year, democrat, state, presid, peopl, right, polit, unit, parti, visit, congress, taiwan, protest, human, trip, time, think, govern, dont, speaker, china, includ, hous, week, say, congression, leader, republican, nation, critic, senat, bill, beij, kong, hong, tiananmen, mani, call, princ, saudi, communist, travel, also, speak, american, tri, squar, moment, two

40	Confucius Institutes in the US	institut, american, univers, confucius, state, center, campus, govern, parti, academ, influenc, educ, program, beij, fund, unit, front, communist, cultur, report, open, foreign, school, depart, offici, administr, activ, oper, languag, effort, freedom, investig, work, abroad, china, last, queensland, year, organ, promot, host, close, senat, valu, concern, public, studi, critic, includ, also

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